

Title: Saving Those Wonderful Wetlands

Brief Overview:

Fourth and fifth grade students will use algebraic thinking to analyze, interpret and communicate data collected from an imaginary wetland that is being adversely affected by human actions. Students will apply problem solving strategies to real world situations as they explore environmental issues. This unit may be used as an instructional resource or a summative assessment.

Links to NCTM 2000 Standards:

- **Standard 1: Number and Operation**

Mathematics instructional programs should foster the development of number and operation sense so that all students understand numbers, ways of representing numbers, relationships among numbers, and number systems; understand the meaning of operations and how they relate to each other; and use computational tools and strategies fluently.

- **Standard 2: Patterns, Functions, and Algebra**

Mathematics instructional programs should include attention to patterns, functions, symbols and models so that all students understand various types of patterns and functional relationships; use symbolic forms to represent and analyze mathematical situations and structures; and use mathematical models and analyze change in both real and abstract contexts.

- **Standard 3: Geometry and Spatial Sense**

Mathematics instructional programs should include attention to geometry and spatial sense so that all students select and use different representational systems, including coordinate geometry and graph theory.

- **Standard 5: Data Analysis, Statistics, and Probability**

Mathematics instructional programs should include attention to data analysis, statistics, and probability so that all students pose questions, organize, and represent data to answer those questions; interpret data using methods of exploratory data analysis; and develop and evaluate inferences, predictions, and arguments that are based on data and mathematics.

- **Standard 6: Problem Solving**

Mathematical instructional programs should focus on solving problems as part of understanding mathematics so that all students build new mathematical knowledge through their work with problems; develop a disposition to formulate, represent, abstract, and generalize on situations within and outside mathematics; make and investigate mathematical conjectures; and develop and evaluate mathematical arguments.

- **Standard 8: Communication**

Mathematics instructional programs should use communication to foster an understanding of mathematics so that all students organize and consolidate their mathematical thinking to communicate with others; express mathematical ideas coherently and clearly to peers, teachers, and others; extend their mathematical knowledge by considering the thinking and strategies of others; and use the language of mathematics as a precise means of mathematical expression.

- **Standard 9: Connections**

Mathematics instructional programs should emphasize connections to foster an understanding of mathematics so that all students recognize and use connections among different mathematical ideas; understand how mathematical ideas build on one another to produce a coherent whole; and recognize, use and learn about mathematics in contexts outside of mathematics.

- **Standard 10: Representation**

Mathematics instructional programs should emphasize mathematical representations to foster an understanding of mathematics so that all students create and use representations to organize, record, and communicate mathematical ideas; develop a repertoire of mathematical representations that can be used purposefully, flexibly, and appropriately; and use representations to model and interpret physical, social, and mathematical phenomena.

Links to National Science Education Standards:

- **Life Science**

Students learn about populations and ecosystems diversity and adaptations of organisms.

- **History and Nature of Science**

Students learn about the nature of science.

Grade/Level:

Grades 4-5

Duration/Length:

4 class periods of 1 hour each and 1 day for final vignette

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- □ Graphing
- □ Basic operations

- Identifying basic patterns
- Use of frequency tables
- Writing skills, including letter writing
- Cooperative learning
- Number sense
- Problem solving strategies

Student Outcomes:

Students will:

- apply number relationships.
- identify patterns in a function table.
- recognize and communicate rules for functions.
- use problem solving strategies to solve multi-step problems.
- work cooperatively in groups.
- create a map and graph to communicate data analysis.
- make predictions.
- write a persuasive letter.

Materials/Resources/Printed Materials:

- Copies of worksheets for each student
- Cubes for building (Each group of 4 students will need a set of 15.)
- Manipulatives for building spans of boardwalk, such as, rectangular attribute blocks, dominoes, or Legos (Each group of 4 students will need a set of 15.)
- Manipulatives for building posts of boardwalk, such as cubes, Cuisenaire rods, or Legos (Each group of 4 students will need a set of 15.)
- Square tiles or pattern blocks to represent pollution spread (Each group of 4 students will need a set of 30.)
- Grid paper
- Crayons, colored pencils, or markers

Development/Procedures:

Day 1 - How Many Visitors?

Students will use simple function tables to project future visitor attendance to Wetlands Park based on past attendance data.

Engaging Activity - In cooperative groups of 4, have students brainstorm a list of parks they have visited and what activities they enjoyed while at the parks. Display lists in class and briefly discuss types of parks and recreation. Compare and contrast how humans use natural areas to how other animals use them. If time allows, discuss differences between parks and refuges.

Distribute Student Worksheet, “How Many Visitors?”, to each group. Have students read and discuss the scenario and problem. Before students begin working on the problem, make sure all groups understand the task. As groups work, cruise the class encouraging students to discuss patterns observed in the input and output columns, relationships seen in those patterns, why they think as they do, and how they arrived at their answers. Facilitate using math vocabulary as they explain rules of the function table.

Discuss the answers as a class and have students explain their answers. Lead students to see the function rule and to create algebraic sentences to project future attendance.

Finally, have students write an explanation of how they solved the problem. They should include math vocabulary, the function rule and a number sentence as part of their explanation.

If time allows, have students discuss what impact the increased number of visitors might have on Wetlands Park.

Day 2 - Where Are All the Birds?

Students will use simple function tables to project future bird populations at Wetlands Park based on past bird count data.

Engaging Activity - Arrange students in cooperative groups of 4. Ask students to brainstorm a list of wildlife they might see at a marsh. Display lists in class and categorize into plants and animals. Briefly discuss reasons why various animals inhabit marshes. If time allows, further categorize animals into groups, such as mammals, reptiles, birds, etc. or endangered and threatened.

Share the following scenario with the class:

In 1993, wildlife officials noticed that fewer wading birds and other water fowl seemed to be using Wetlands Park for resting, nesting and feeding. They asked the local Audubon Society to conduct annual bird counts, focusing on wading birds and ducks. In 1994, the first year of the study, Audubon reported an estimated 1500 birds of the targeted species. In 1995, year 2 of the study, the estimated count was 1400, in 1996 - 1300, and in 1997 - 1200. Using this data, predict how many birds will be sighted in 2003, year 10 of the study. In addition, wildlife officials want to know when the estimated count will drop below 250.

*Note to teacher - Caution students to record year of study (1, 2, 3, etc), not the calendar year (1994, 1995, 1996, etc.). To provide simple data, fictional bird count figures were created. Species populations would not fluctuate in even patterns like this.

Encourage students to discuss the information given in the scenario, to identify the problem and share ways to organize the data. Reread the problem for students to copy the data. Instruct groups to solve the problem and to share strategies and solutions.

As in Task 1, cruise the class encouraging groups to discuss patterns observed in the input and output columns, relationships seen in those patterns, and how they obtained their answers. Facilitate using math vocabulary as they explain function rules.

Go over answers as a class and have students explain their answers. Lead students to see the function rule and to create algebraic sentences to project future bird counts.

Have students write an explanation of how they solved the problem. They should include math vocabulary, the function rule, and a number sentence as part of their explanation. If time allows, have students discuss possible reasons for the decline in bird populations at Wetlands Park.

Extension/Challenge - Students may extend and graph the data from Day 1 and 2 for a ten-year period. Have them compare the 2 graphs (or make a double line graph!) and look for relationships. How might these 2 events be related? Students may research to find what birds inhabit local wetlands and to study population fluctuations.

Day 3 - Building Boardwalks

Students will use manipulatives and function tables to predict needed amounts of materials for building nesting boxes for wood ducks.

Engaging Activity - Arrange students in cooperative groups of 4. Ask students to brainstorm a list of things students can do to help endangered species. Briefly share lists and discuss how individuals and groups can make a difference in solving problems.

Share the following scenario with the class:

You have decided that in order to help the decreasing bird populations that use Wetlands Park for nesting, you will build nesting boxes for wood ducks. A local lumber company has agreed to donate the lumber and cut the boards into square sides for the boxes. The neighboring high school environmental club has agreed to help you assemble the nesting boxes and place them in the marsh. Your job is to find the amount of square boards the lumber company must cut for your project.

Discuss the information given in the scenario, identify the problem and share ways to organize the data. Explain that you will begin exploring the problem as a class. Pass out sets of cubes to each group of four.

1. Groups will use cubes to represent the nesting boxes and find the area of a length of boxes. Have students start with one cube. Ask, "What is the surface area of this box?" (6 square units) Encourage students to record data.
2. Instruct groups to place another cube adjacent to the first block to begin forming a connecting row of nesting boxes. Point out that to save lumber, the connecting boxes will share a side. Ask, "How many square sides are needed in this row of 2 boxes?" (11 square sides) Have students record data.
3. Repeat the same procedure to add a third and fourth adjoining box. Explain that each square unit represents 1 square board or side of the nesting box.
4. Ask questions such as, "If this pattern continues, how many sides would we need for 7 cubes or boxes? If you have 101 square boards, how many nesting boxes could be built?" Have groups work to solve these problems. (Answers - 7 cubes requires 36 boards. 101 square boards would build 20 boxes.)

As before, cruise the class encouraging groups to discuss patterns and relationships, problem solving strategies, and why they think as they do now.. Facilitate using math vocabulary as they explain rules of the function table. Once groups have discovered the rule, remind them to check their solutions against the known data.

Go over answers as a class and have students explain their answers. Lead students to see the function rule and to create algebraic sentences to predict amounts of materials needed to build the boxes. Have students explain why the algebraic formula includes +1.

*Function rule is $S = (C \times 5) + 1$, where S is # of sides and C is # of cubes (nesting boxes). (Any letter may be used as a variable, but it should have some meaning from the problem.)

5. As an individual assignment, have students solve these additional problems, using their data. If we wanted to build 15 nesting boxes, how many boards would we ask the lumber company to cut? If the lumber company already has 54 boards cut, how many boxes could the high school students assemble? Encourage students to justify their answers by explaining the function rule and how they solved the problem. Require students to include a diagram, data table and number sentence. (Answers - 15 nesting boxes would require 76 boards and with 54 boards, one could build 10 boxes with 3 boards remaining.)

Day 4 - Building Boardwalks

Students will use manipulatives and function tables to predict needed amounts of materials for building a boardwalk over a sensitive wetland area.

Engaging Activity - Arrange students in cooperative groups of 4. Ask students to brainstorm a list of ways managers and rangers protect the land and wildlife within their parks and refuges. Briefly share lists and discuss why protection efforts are necessary.

Share the following scenario with the class:

Park Rangers have noticed that as the number of visitors have increased at Wetlands Park, the population of water birds has decreased. Thinking the increased foot traffic might be harming sensitive wetland vegetation and overall health of the habitat, they have decided to build a boardwalk that meanders through the marsh to protect the land and wildlife. The boardwalk will be built in sections, with each section or span having 4 supporting posts.

Discuss the information given in the scenario, identify the problem and share ways to organize the data. Explain that you will begin exploring the problem as a class. Pass out building materials (Large and small Lego bricks, or Cuisenaire rods and rectangular pattern blocks).

1. Have groups use Legos or other manipulatives to build a bridge. To build the first section, have students use 4 small square bricks or rods for the posts of the first section and then place a large brick or rectangular block on the posts to add the span. Encourage students to record data. (1 span requires 4 posts)
2. Instruct groups to build the second section by using 2 more small bricks or rods and 1 more large brick or block. Have students record data. (2 spans requires 6 posts)
3. Repeat the same procedure to add a third and fourth section to the boardwalk. Ask questions such as, "If we continue building the boardwalk, how many posts are needed to build 16 spans or sections? How many spans are needed if you place 26 posts?"

Instruct groups to solve the problem and to be ready to share strategies and solutions with the class.

As before, cruise the class encouraging groups to use math vocabulary as they discover data relationships, function rules and the problem solving strategy used. When students translate the function rule into an algebraic sentence, ask them to justify each variable and constant. Function rule is $P = (S \times 2) + 2$, where P is # of posts and S is # of spans.

Go over answers as a class. and have students explain how they arrived at their answers. Finally, have students write an explanation of how they solved the problem. They should include a diagram, math vocabulary, function rule and a number sentence as part of their explanation.

Extension/Challenge - Students may create a model, diagram or map of a fictional wetland park that includes a boardwalk through special areas. They could develop a brochure that highlights interesting sites and wildlife along the walk.

Day 5 - Pinpointing the Pollution

This problem solving vignette can be used as the cumulative project for this learning unit. Students will use function tables to project the spread of wetland habitat degradation, and then will communicate findings and make recommendations to city officials about the problem.

Share the following scenario with the class:

Wetlands Park officials have noticed the many changes in the marshes over the last several years. In addition to a decrease in animal populations, nuisance plant species have begun to invade and out compete the wetland species. This new problem is most noticeable at the northwest corner of the marsh near the city's municipal park and recreation area. The rangers will begin a study to find possible causes, believing some type of pollution could be causing these changes. Your class has also noticed changes in the marsh on field trips and you want government officials to help solve the problem.

Your class decided to work with the rangers to study the problem by observing where nuisance plants are taking over natural wetland plants. The data collected will help project the area and rate of the spreading destruction. At the beginning of the study, rangers observed 1 square yard of nuisance plants growing in the northwest corner of the marsh. In the second month of the study, data collected shows the wetland vegetation had changed in a 4 square yard area. Over the third month the changing vegetation spread south and east, and covered an area of 9 square yards. In the fourth month, the affected area covered 16 square yards. In the fifth month, the affected area totaled 25 square yards. Project the area that would be affected in 6 months.

Discuss the information given in the scenario, identify the problem and share ways to organize the data. Explain that you will begin exploring the problem as a class. Pass out square tiles to each group of four students.

1. Have students place 1 tile to symbolize the first square area of affected vegetation. Encourage students to record data. (1 month - 1 square yard)
2. Next, have them add tiles along the south and east sides until they have 4 square units. Have students record data. (2 months - 4 square yards)
3. Repeat the same procedure to increase the third month's affected area to 9 square units and the fourth month's affected area to 16 square units. Instruct students to record data. (3 months - 9 square yards, 4 months - 16 square yards) Ask students to predict the size of the affected area in 6 months?"

Instruct groups to solve the problem and to be ready to share strategies and solutions with the class. Cruise the class to encourage math talk about strategies and justifications.

4. As a class, share answers, strategies, function rules and algebraic sentences.

5. Pass out Student Worksheet, “Pinpointing Pollution - Ranger Guidelines”, to each student. Go over the scenario together and make sure all students understand what is expected. Have them work in groups to prepare and present at a town meeting.

Here are some added instructions to complete the grid. You may choose to have this be a more independent activity.

Give each student a piece of grid paper. First, have the students draw in a vertical line along the left-hand edge of the grid and a horizontal line along the top of the grid. These are the two coastlines. Students should label these. Have each student color the first month’s pollution coverage (one square in the upper right-hand corner of the grid. This square should be touching the two coastlines.) Next, the student will color the second month’s coverage of pollution in a different color. (These would be the squares on the right edge and bottom edge, including the corner of the first square colored.) The children should continue this pattern to illustrate the next months’ pollution coverage. The students should also make a key showing each color and the month to which it corresponds on the illustration. Remind the students to look at the tile if they are having difficulty visualizing what is expected.

**Optional Writing Prompt for Letter*

You have just completed a study on the projected pollution of Wetlands park. Write a letter to persuade government officials to help solve the pollution problem. As you are creating your letter think about the data you collected from your graph and illustration, and why you want the wetlands in your area to be preserve. Remember to consider the correct form of a letter and rules concerning grammar, spelling punctuation, and usage.

6. At the day’s end, allow students to present their studies to the class. Classmates can pretend to be city officials and respond to the studies by asking questions about the finding and the groups’ proposals.

Performance Assessment:

Rubric for Day 3 Project

- 4** - Uses appropriate math language
 - All details are in an appropriate sequential order
 - Problem solving strategy is identified
 - Answers given are reasonable and justified
 - Includes diagram and number sentence

- 3** - Uses some appropriate math language
 - Most details are in sequential order
 - Problem solving strategy evident, but not clearly identified
 - Most answers given are reasonable and justified
 - Includes diagram and number sentence
- 2** - Uses little appropriate math language
 - Few details in sequential order
 - Problem solving strategy not identified
 - Most answers are reasonable, but not justified
 - Includes a diagram or a number sentence
- 1** - No math language used
 - Limited detail
 - Answers not reasonable or justified
 - Includes a diagram or a number sentence

Rubric for Final Vignette

- 3** - The data presentation is in the form of a chart or graph, shows increasing pattern of spreading nuisance vegetation, is labeled clearly and color coded, and includes explanation of data results and how projections were computed.
 - The visual representation of “Spreading Nuisance Vegetation in Wetlands Park”, is a gridded map or a gridded model, monthly spread can be easily identified, is clearly labeled and has a key.
 - Letter to Communicate Concerns includes a summary of data findings, proper business letter form, affects to wetlands, and recommendations.
- 2** - Two of the three items are completed correctly.
- 1** - One item is completed correctly.
- 0** - No items are completed correctly.

Extension/Follow Up:

There are several extension ideas in which your class may participate:

- ☐ Have a park ranger or naturalist visit and speak to your class about the wetlands and types of things that are harming them.
- ☐ Take your class on a field trip to the local park where there are wetlands.
- ☐ Research what types of things are harming the wetlands.
- ☐ Have students create campaign posters to save the wetlands.

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How Many Visitors?

The manager at Wetlands Park wants to begin tracking the number of people that visit the park each year so he can plan future events and to see what impact the visitors might have on the wildlife. In years past, most visitors have signed in at the entrance gate, so those records will give an estimate of park attendance. After reviewing the old sign-in sheets, one ranger organized the data into the chart below. Notice that some figures are missing because some records were lost.

The table shows the estimated annual number of visitors who come to Wetlands Park.

Actual Year	Year #	# of Visitors
1993	1	50
1994	2	100
1995	3	150
1996	4	200
1997	5	
1998	6	
1999		350
2000		400
2001	9	

1. Complete the table.
2. The park manager wants to know how many visitors will probably come to the park in the year 2005.
3. The manager also wants to predict what year park attendance will reach 1,000.
4. Write the rule for this function table and tell what strategy you used to solve it.
5. Tell how to find the number of years when you know the number of visitors.

How Many Visitors? - Answer Key

The manager at Wetlands Park wants to begin tracking the number of people that visit the park each year so he can plan future events and to see what impact the visitors might have on the wildlife. In years past, most visitors have signed in at the entrance gate, so those records will give an estimate of park attendance. After reviewing the old sign-in sheets, one ranger organized the data into the chart below. Notice that some figures are missing because some records were lost.

The table shows the estimated annual number of visitors who come to Wetlands Park.

Actual Year	Year #	# of Visitors
1993	1	50
1994	2	100
1995	3	150
1996	4	200
1997	5	250
1998	6	300
1999	7	350
2000	8	400
2001	9	450

1. Complete the table.
2. The park manager wants to know how many visitors will probably come to the park in the year 2005.
Ex: There will be 650 visitors in the year 2005, based on the given data.
3. The manager also wants to predict what year park attendance will reach 1,000.
Ex.: Based on the given data, park attendance should reach 1,000 in the year 2012.
4. Write the rule for this function table and tell what strategy you used to solve it.
Rule - $V = Y \times 50$, where V is the # of visitors and Y is the number of years
5. Tell how to find the number of years when you know the number of visitors.
Example: To find the number of visitors, you should use the inverse of the rule and divide the number of visitors by 50 to get the year number. Then you must apply that year number to count up to the correct calendar year.

Pinpointing Pollution - Ranger Guidelines

Your class met with the Wetlands Park rangers to analyze the data collected so far and to discuss your projections concerning the spreading nuisance vegetation. You have also shared your ideas about sharing this information with city officials so they can help protect the sensitive wetlands. The rangers suggested you prepare the following items and then present them to the city officials at next month's town meeting.

Data Presentation

- Should be in the form of a chart or graph
- Should show increasing pattern of spreading nuisance vegetation
- Should be labeled clearly and color coded
- Should include explanation of data results and how projections were computed

Visual Representation of Spreading Nuisance Vegetation in Wetlands Park

- Should be a gridded map or a gridded model
- Monthly spread be easily identified
- Should be clearly labeled and have a key

Letter to Communicate Concerns

- Should include summary of data findings
- Should include proper business letter form
- Should include affects to wetlands
- Should include recommendations